FOREST PEST MANAGEMENT
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# BIOLOGICAL EVALUATION OF PEST CONDITIONS ON THE CAJON, ARROWHEAD, AND SAN GORGONIO RANGER DISTRICTS, SAN BERNARDINO NATIONAL FOREST

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## ABSTRACT

At Starkey Forest Plantation on the Cajon Ranger District, moisture stress, overstocking, and inhospitable site conditions contributed to the mortality of pines during 1982. Near Blue Jay on the Arrowhead District, we examined a mixed conifer stand that is a candidate for an Integrated Pest Management demonstration. At Banning Station, San Gorgonio District, we concluded that Armillaria root disease, overwatering, root damage, and harsh site caused the deaths of four giant sequoias, ages 60-70 years. Management alternatives are described for each pest condition.

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At the request of Cajon District Ranger Ernest Dierking, we visited Lytle Creek Station on March 14, 1983 to investigate the causes of 1982 pine mortality at Starkey Forest Plantation. Forest Silviculturist Jim Bridges accompanied us, and District Resource Officer Loren Jones showed us around the site. In the afternoon, Bridges showed us a stand near Blue Jay on the Arrowhead Ranger District where the Forest is contemplating a demonstration of Integrated Pest Management (IPM).

On March 16 we drove to Banning Station to examine four large giant sequoias that died recently. This evaluation was in reponse to a pest detection report sent by Ronald Hunt of the Mill Creek Station on October 24, 1982. No one was present at Banning during our visit.

## STARKEY FOREST PLANTATION

The Starkey Forest Plantation covers less than 5 acres and surrounds the Lytle Creek Ranger Station on the Cajon Ranger District. The Ranger Station and plantation are located at about 3,000 feet elevation. The

soil in the area is primarily sand and gravel from the Lytle Creek wash. There are apparently no naturally-occurring conifers in the canyon bottom near the plantation, although bigcone Douglas-fir is native to the north-facing slope.

The plantation was initiated in the 1930's and 1940's, although there were some later plantings. The older plantings were primarily Coulter and knobcone pines with some incense-cedar and a few Arizona ash. The plantation was reportedly watered for some time after establishment. A small number of trees were cut in the past. Growth rings indicated excellent radial growth for the first 10 years, followed by slower growth. The largest trees in the plantation were over 21 inches dbh and the average was around 14-16 inches dbh.

Tree mortality caused by bark beetles and engraver beetles began to occur in the plantation during 1982. Most of the mortality was concentrated in one center, resulting in a spot about 100 feet in diameter which is devoid of trees. No root disease or current bark beetle activity could be detected in the mortality spot. The older part of the plantation was thinned during late 1982 and early 1983. The basal area in the thinned aggregations ranged from about 120 to 160 square feet, but each aggregation was bordered on one or more sides by an open area, which probably reduces the overall effect of the basal area on tree stress. The ground in the older part of the plantation was covered with grass and forbs.

## DISCUSSION

The immediate area near the Starkey Forest Plantation does not appear to support conifers. The conifers in the plantation consist of native California trees of unknown seed sources, hybrid pines, and trees not native to the area, including giant sequoia, spruce, and Arizona cypress. The plantation is growing on a porous floodplain rather than forest soil. For these reasons, it is difficult to determine the appropriate stocking level, although it is probably low.

The situation is further complicated by the wide fluctuations in annual precipitation received at the Ranger Station. During the past four decades the annual precipitation has ranged from 10.87 inches during 1953 to 88.55 inches during 1978, and has been below the longterm average for as long as six consecutive years, from 1959 to 1964.

The mortality seen in the plantation during 1982 appears to be related both to the stocking level and to drought. During the period from June 1980 through December 1981, the precipitation received at the Ranger Station was below the longterm average for 16 of the 19 months. The moisture stress in a few trees probably allowed bark and engraver beetles to successfully attack them. The bark and engraver beetles that attack pines have pheromones which attract more beetles of the same species toward the tree under attack. If the beetles drawn toward the tree under attack land on nearby healthy trees and successfully attack them, a mortality group like the one at Starkey Forest will result.

No evidence of beetle attack was seen on the green trees in the plantation and, with the return to more favorable moisture conditions during 1982 and 1983, little additional mortality should occur this year. The plantation will probably undergo stress at some point in the future as the basal area increases with time and future periods of below-normal precipitation occur. Tree mortality is likely to occur during future stress periods unless mitigating measures are taken.

## MANAGEMENT ALTERNATIVES

Do Nothing. There should be little or no mortality in the plantation for the next few years. The crowns and roots of the trees should expand into the openings left by the thinning within a few years, and the basal area should increase slowly. The grass and forb ground cover will rapidly deplete the moisture in the root zone of the trees each spring. There will probably be substantial tree mortality during a future period of below-normal precipitation.

Conduct Additional Thinning. The soil in the plantation is extremely sandy and the stand has already been opened substantially. Additional thinning before the root systems expand to occupy the available space may result in windthrow. Gradual thinning as the individual trees increase in size to maintain a relatively open stand of about 80-100 square feet basal area will aid in keeping the trees vigorous enough to resist bark beetle attacks.

Remove Grass and Forbs. If the grass and forb ground cover were removed from the plantation early in the growing season, it would conserve the amount of moisture available to the trees.

1) The use of herbicides to reduce the ground cover would cause the least amount of disturbance to the trees, but this may not be feasible because Lytle Creek is a domestic water supply for the city of Fontana.

2) Prescribed burning could reduce the leaf surface area of the ground cover available to transpire, but the benefits of the additional moisture could be offset by scorching caused by the burn. Stresses caused by burning could be particularly damaging if the plantation has not fully recovered from the effects of drought and thinning.

3) Discing the plantation could temporarily reduce the ground cover, but it has the potential to cause additional stresses through cutting of the fine roots, bole skinning, and soil compaction.

Supplemental Watering. The vigor of the plantation would be improved if it was watered during prolonged dry periods. The best results would be obtained by periodically injecting water into the root zone at a depth of 1 to 2 feet and allowing the soil to dry between each watering. Constant irrigation of the surface is likely to waterlog the soil in the root zone, which will stress the trees and make them susceptible to Armillaria root disease.

Protective Insecticide Treatment. If it becomes apparent that the plantation is entering a period of stress, such as that caused by drought, the main stem of each pine could be treated from the ground with a hydraulic spray of Sevimol 4. The treatment would provide over 80 percent protection from bark beetle attack for a period of one year. An Environmental Assessment and Pesticide-Use Proposal would have to be prepared prior to treatment. An insecticide treatment in the Starkey Forest plantation during 1983 would probably have no effect on tree mortality, based on the current state of vigor.

Convert Plantation to Local Species. It will probably take a continual input of resources to maintain a concentration of trees around the Ranger Station. The amount of input could likely be lowered from the amount necessary for the current plantation by utilizing extremely local seed sources as replacements are needed. Live oak, sycamore and local Coulter pine would be appropriate and bigcone Douglas-fir may also survive.

## DEMONSTRATION STAND AT BLUE JAY

The proposed IPM demonstration stand is a 40-acre parcel southeast of Blue Jay (T. 2N, R. 3W, sec. 20); adjacent properties are mostly private homesites. The overstory is comprised of mature and overmature white fir, ponderosa pine, sugar pine, and incense-cedar; the conifer understory is pole-size and smaller white fir, sugar pine, and incense-cedar, with fir predominant and ponderosa pine absent.

We did not examine the stand thoroughly, but we did note several conditions that should be considered in any proposed management. White fir mortality was noticeable, though not excessive; overstocking was confined to dense patches of pole-size and smaller fir. We found conks of Fomes annosus in one white fir stump, and noted that 15-20 percent of the ponderosa pine overstory exhibited various degrees of smog (ozone) injury. Dwarf mistletoe was infecting several of the ponderosa pines.

## MANAGEMENT CONSIDERATIONS

While planning treatment for this stand, the Forest should consider the following alternatives as they relate to the specific pest and stand conditions described above. If the stand is selected as an IPM demonstration site, the Forest should ask FPM to perform a more thorough evaluation at that time.

Take No Action. Without treatment, white fir will become more dominant in the stand. Fir mortality may increase in densely-stocked pole-size aggregations and wherever annosus root disease is present. Although ponderosa pine probably will not die within fir root disease centers, many of the remaining older pines will succumb to smog injury and their regeneration will be crowded out by the fir; dwarf mistletoe will intensify in the already-infected pines. Incense-cedar, sugar pine, and hardwoods may find a niche wherever white fir fails. Accumulation of fuels from dead pine and fir will increase the fire hazard.

**Thin Overstocked Fir Aggregations.** Thinning will increase the vigor of the fir, make them more resistant to fir engraver (Scolytus ventralis) attack, and encourage new root growth to replace roots lost to annosus decay. To reduce the decay that develops behind logging scars, prevent injury to residual trees during stand entries.

**Plant Smog-Tolerant Ponderosa Pine.** Plant pine in fir root disease centers and in patch cuts of overmature pine and fir aggregations. Select local seed from ponderosa pine that exhibit healthy crowns in contrast to the thin, chlorotic foliage of nearby susceptible pines. Active manipulation of the ponderosa pine in this way may help stem its decline in stands where air pollution, white fir, and fire control have prevented successful regeneration.

**Encourage a Mixed-Species Stand.** Utilize the abundance of species on the site to increase variety and to prevent host-specific pest problems such as those caused by western dwarf mistletoe in ponderosa pine and annosus root decay in white fir. For example, sugar pine is a relatively pest-free species, and its growth and regeneration appear to be good in this stand. White pine blister rust has not been found in southern California.

**Treat Dwarf Mistletoe.** Ponderosa pine plantings should be isolated from infected overstory pines, and severely infected trees (mistletoe rating 5-6) should be removed. Where infected ponderosa pines must be retained for esthetic reasons, leave a host-free buffer zone around them equal in width to the height of the highest mistletoe plant in the overstory; prune mistletoe brooms from especially valuable pines to increase their vigor and longevity. Dwarf mistletoe in true firs will not be a problem if their growth is rapid enough to outgrow the upward spread of the parasite.

## GIANT SEQUOIAS AT BANNING STATION

In October 1982, Ronald Hunt from the San Gorgonio Ranger District sent FPM a detection report, requesting that we identify what killed four of five large giant sequoias (Sequoiadendron giganteum) at Banning Station. At the time we replied that, although it was difficult to tell from the samples, "Armillaria root disease, combined with excessive moisture, is the likely cause of mortality." On March 16 we visited the site to find out firsthand.

### OBSERVATIONS AND DISCUSSION

The four dead giant sequoias were lying bucked and limbed where they had fallen after being cut. All four trees were about 30-36" dbh, and the top of one appeared to have died several years ago. Extensive mycelial fans of Armillaria mellea, the cause of Armillaria root disease, were present beneath the bark of all four butt logs up to more than four feet above the ground; the stumps and root collars were also covered with the tough, white mycelium.

The larger roots of some trees had grown partially around the bases of the stems, obstructing the sap flow as the trees increased in diameter. Such girdling roots are a frequent cause of tree decline in urban and domestic plantings. The girdling roots probably developed early, perhaps in the pots in which the trees were grown in the nursery, or after transplanting into holes too small for the roots to develop and spread normally.

All five trees were between 60 and 70 years old, and the four dead ones had grown very slowly in the last 15 years. The single live tree had healthy-colored foliage, but its crown was flat-topped. In samples taken with an increment borer, we did not find A. mellea mycelium beneath the bark of the live tree; to avoid damage we did not chop into the root collar.

The remaining live sequoia is next to a lawn, and the four stumps are in a row 4-6' apart toward the east. Near the farthest stump there appear to be the remains of an old oak, which may have been the source of the Armillaria infection. The roots of all five sequoias were damaged by a 3-4' deep excavation which was reinforced by a concrete block wall; the cut for the wall was made within 2-4' of the bases of the trees, and probably destroyed several large roots and injured many more. Electrical cables were also buried underground, causing further injury to the roots. The ground at the base of the trees has a luxuriant growth of grass, iris, and elderberry, and a nearby sprinkler indicates that the area is heavily watered. All these conditions point to the likely cause of death -- Armillaria root disease girdled the trees after they had been weakened by overwatering, root damage, and the stress of growing in a site to which they were not adapted.

## CAUSAL AGENT

Armillaria mellea is a common soil fungus that can affect a wide range of trees, shrubs, and herbaceous plants. It causes decay in dead or dying hardwoods and softwoods, and is capable of killing young, diseased, moisture-stressed, or off-site plants. In native forests it is usually associated with oaks, but does little harm to them as long as they remain healthy. When an oak dies or is cut, however, the fungus invades the roots and stump, utilizes the food base that the dead wood provides, and forms dark, string-like fungal structures (rhizomorphs) that are capable of growing short distances through the soil to attack conifers within the root zone of the dead oak. Conifer seedlings are especially susceptible, while healthy trees older than 15 years of age are more resistant.

## PROGNOSIS

The last large sequoia appears to have reached its limit of growth for the site and climate. Its physiological condition, coupled with root loss, overwatering, and probable Armillaria decay, suggest that it will not survive many more years.

A 7" dbh sequoia has been planted in the middle of the lawn. Although it shows no evidence of root injury or crown decline, it probably will

succumb eventually to overwatering and Armillaria root disease. If the District were to remove the lawn from the base of the tree to well beyond the drip line of the crown, cease using the sprinkler, and practice periodic deep watering, the young sequoia may survive to the 60-70 years that the others reached. For this site, however, planting oaks or other locally-adapted hardwoods will be a better long-term investment.